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AUTHOR	Weld, Jeffrey
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ABSTRACT

The numbers indicate that science teachers are not reaching ethnic minority students as effectively as they could. The research literature is rife with recommendations for remediation. But many of these cures do more to sustain a style of science education that perpetuates cultural bias than they do to help all students achieve. Multiculturalists and science teachers, who wish to maintain fidelity in the discipline, want all students to appreciate the scope and limitations of science, the cultural influences that have and will color it, the societal manifestations of it, and the opportunities inherent within it. But teachers should not abandon learning theory to "deliver" these notions when student inquiry will better provide for the construction of these meanings for each individual. (Contains 24 references.) (CCM)

LESS TALK, MORE ACTION, FOR MULTICULTURAL SCIENCE

Jeffrey Weld, University of Iowa

The numbers indicate that science teachers are not reaching ethnic minority students as effectively as they could. The research literature is rife with recommendations for remediation. But many of these "cures" do more to sustain a style of science education that perpetuates cultural bias than they do to help all students achieve. As multiculturalists and as science teachers who wish to maintain fidelity to our discipline, we all want students to appreciate the scope and limitations of science, the cultural influences that have and will color it, the societal manifestations of it, and the opportunities inherent within it. But we should not abandon learning theory to "deliver" these notions when student inquiry will better provide for the construction of these meanings for each individual.

The Historical Context

Consider the four sample questions below– they're part of a forty-question battery called the Army Alpha Test 8: Information instrument that was administered to soldiers during World War I.

1. The Knight engine is used in the:
   a. Packard b. Lozier c. Stearns d. Pierce Arrow

2. Isaac Pitman was most famous in:
   a. physics b. shorthand c. railroading d. electricity

3. The stanchion is used in:
   a. fishing b. hunting c. farming d. motoring

4. Cheviot is the name of a:
   a. fabric b. drink c. dance d. food

A high score was a virtual guarantee of stellar opportunities in the armed services. Missing half was the equivalent to a scarlet letter classification of mental inferiority which followed the infantryman for life. The test had been developed by the American Psychological Association as a means for determining who was intellectually fit for advancement, and who was to be classified as "feebleminded" (Paul, 1995). How do you rank?

Nearly two million soldiers took this proto–I.Q. test. When the results were released after the war, it was revealed that "the lowest scores were registered by Blacks and members of newer immigrant groups" (Paul, 1995); 47.3 percent of them had been declared feebleminded based upon the test. The outcome resonated throughout American society, and spawned more such tests to be administered to school children and workers, all used for promulgating a vision of supremacy among the white middle and upper classes who ranked highest on these misguided intelligence measures (Paul,1995).

Viewing the test and its implications through the corrective lens of hindsight, one can fully recognize the inherent bias associated with it. A select population of test-takers were favored--specifically those belonging to the same cultural, socioeconomic, and even geographic population as the test's authors. How obviously naive a design and intent, we might think. Who among America's poor (disproportionately minorities and recent immigrants) would stand a chance when simply owning a motorcar was a luxury far beyond reach, let alone a Stearns with its Knight engine?

Yet here we are eighty years later using antiquated notions of learning and assessing our progress with one-size-fits-all standardized tests to determine such modern rites of passage as college entrance and professional certification. And by all indications, biases persist. The 1993 assessment report of the American College Testing service revealed that every minority group in America scored lower mean composite scores than did Caucasian American/White examinees (Walton, 1993). Moreover, Hispanic students consistently achieve at a lower level than their Anglo peers in school (Rakow and Bermudez, 1993) and it has been conservatively estimated that 18 percent of Black males drop out of high school (Wright, 1992).

There is now no question that the relationship between educational attainment and ethnicity points toward underachievement for the children of America's ethnic minorities (Hodson, 1993). This disparity is particularly pronounced in school science coursework at the secondary and tertiary levels (Hodson,1993), accounting, no doubt, for the dramatic underrepresentation of minorities in scientific careers (Blake, 1993). In light of this prevailing condition, it is not surprising that minority students have been found to hold less confident attitudes about their own capabilities and the future pursuit of science as a career (White and Richardson, 1993).

The question of culpability, and a search for remediation therefore become issues of great national import. It cannot bode well for a nation where only 2.9 percent of all practicing scientists and engineers are black despite a national population percentage of 11.9 percent. And likewise among Hispanic Americans-- comprising over 9 percent of the population and growing more rapidly than any other ethnic minority group-- to whom only 1.3 percent of bachelor degrees in the sciences are awarded (Rakow, 1985, Atwater,1994, Foundations, 1997). Something is clearly turning the children of minority ethnic cultures off to science. The numbers portend a gloomy picture for the profession as well as for society as a whole: in the twenty years it will take for today's students to hit full stride in the workforce, half of America's population will be comprised of people of color (Banks, 1992), and we can ill afford to have half our population disenfranchised from scientific careers. All of tomorrow's adults will live in a rapidly changing technological environment, and their attitudes toward that change will influence their ability to cope with it in emotional as well as material ways (Mordi, 1993).

Thus it is in all of our best interests to examine the process by which students learn about, and develop attitudes regarding, science. The evidence supports the presence of cultural bias in the process. Within our culture, it is schools specifically that must carry the burden of ameliorating such bias, as the science classroom has been shown to have the single greatest influence upon attitudes and career outlooks for adolescents toward science (White and Richardson, 1993).

A Contrast in Viewpoints

Something is amiss in the way that science is too often taught. Many science teachers are not reaching all of their clientele with equal efficacy. This begs the ultimate question to be explored here: should the ethnic and cultural make-up of our clientele influence the way we teach science? Those who believe the answer is "yes" have proposed an eclectic array of strategies and techniques for shoring up the confidence and subsequent performance of underrepresented minorities in science class.

These strategies include altering the "language of science education," "taking more account of the religious beliefs and customs" of our students, highlighting the "contributions of non-Western and pre-Renaissance scientists" (Hodson,1993), the incorporation of "ethnoscience" (Rakow and Bermudez, 1993), providing role models of students' own ethnicity in the form of teachers and mentors (Wright, 1992), the promotion of culture as the center of the educational process (Holt, 1992), the "introduction of concepts via materials and examples from both the dominant culture and the specific ethnic culture of the students" (Allen and Seumptewa, 1993), and the segregation of students along ethnic lines in a tactic termed "ethnic streaming" (Wright, 1992; Loving,1993).

Answering "no" to the focal question of this discussion is not to be construed as a denial of the existence of pervasive bias in science education. Rather, this view holds that cultural bias can be overcome more equitably and more pedagogically soundly by implementing an inquiry approach to science education, with themes built around science/technology/society, and employing strategies that have been empirically derived to be successful and which form the basis for the National Science Education Standards.

A thesis for the argument put forth herein is that the only truly multicultural science classroom is one that accords students the opportunity to identify problems and issues of a relevant nature, to explore these issues collaboratively through every avenue the school setting can bring to bear, and to derive meaning from those experiences such that each student can gain a clearer understanding of the natural world and their place in it.

Science For All

General consensus exists regarding the goals of science education. Conscientious science teachers hope that their students find science to be "fun and interesting" and that each student develop the attitude that he or she "can do science" (Penick, 1997). Stated formally through the National Science Education Standards, our goals are to educate students who are able to:

- experience the richness and excitement of knowing about and understanding the natural world
- use appropriate scientific processes and principles in making personal decisions
- engage intelligently in public discourse and debate about matters of scientific and technological concern
- increase their economic productivity through the use of the knowledge, understanding, and skills of the scientifically literate person in their careers (National Research Council, 1996)

These goals are congruent with an inquiry approach to the teaching and learning of science. Inquiry science is characterized by a classroom atmosphere in which students "engage in the description of objects and events, ask questions, construct explanations, test those explanations against current scientific knowledge, and communicate their ideas to others" (NRC,1996). In short, inquiry science is an active process, where "learning science is something that students do, not something that is done to them" (NRC,1996).

Multiculturalism: Sound Motives, Suspect Strategies

The intervention strategies advocated in much of the multiculturalist literature depart from the general principles of inquiry science. The recommendations are geared toward traditional science settings where lecture and student passivity prevail. For example, science teachers are urged to utilize "more photographic slides and visual aids" when lecturing to the "highly visual and low verbal-expressive" Western Teton Sioux students (Atwater, 1994).

Moreover, augmenting a traditional lecture with "story situations that include food, places and events" have been found to benefit Native American students (Atwater, 1994). Multiculturalism advocates implore teachers to "use examples and content from a variety of cultures, groups, and their own personal experience" to help make science more exciting (Atwater, Crockett and Kilpatrick, 1996). Teachers are urged to cite the scientific "contributions of females and scientists of color" in their curriculum (Atwater, Crockett and Kilpatrick,1996), and to charge students with conducting "racism checks" of course materials (Williams,1994). Should laboratory time arise amidst the stories,vignettes, and readings, one multiculturalism advocate cites the danger of using "complex and expensive equipment that may implicitly promote the view that science is the preserve of the rich, industrialized nations" (Hodson, 1993).

When coupled with the intervention strategies briefly mentioned earlier, the premise under which many multiculturalism advocates operate becomes clear: that "the priorities of schools with high ethnic minority populations will be significantly different from those in schools in which the student population is drawn largely from the dominant culture" (Hodson, 1993). Educational equity is a reachable goal, but it will come through the widespread adoption of inquiry science practices rather than as a series of contrivances that aid and abet a pedagogical status quo. Multiculturalists' noble intent notwithstanding, the energy expended to promote this particular collection of remedies is miss-spent for three reasons: 1) multicultural interventions themselves assume monocultures of minorities in classrooms; 2) the multicultural literature speaks of all members of particular ethnicities as if cut from the same mold; and 3) the foundations for an ethnically inclusive science education strategy are already at hand.

The typical teacher in a Fresno, Miami or Chicago classroom may have as many ethnic cultures represented as there are students in the classroom (Loving,1995). The task of validating each student's culture through citations of significant contributors to the current body of knowledge becomes a futile and patronizing practice (Williams,1994). Inevitable marginalization would be the end result in a class where every topic discussed must be presented from the perspectives of the different cultures represented in the room (Good, 1995). It may be argued that these are isolated pockets of ethnic heterogeneity; that in reality, ethnically homogeneous student groupings prevail where multiculturalist interventions are warranted. The assumption now becomes one of student uniformity of vision.

Research on learning styles according to ethnicity has resulted in the delineation of broad categories of learners--labeled as field dependent or independent (Oakes, 1990; Baptiste, 1993), of western or non-western world view (Anderson, 1988), and various subcategorizations on these themes regarding visual and perceptive classes of learners (Atwater, 1994). Sweeping generalizations of students have been made to support the adoption of different teaching strategies dependent upon the ethnic make-up of the classroom. One multiculturalist contends that students with non-western world views, namely "African Americans, Chinese Americans, Mexican Americans, Native Americans, and many European American females, value group achievement, think holistically, embrace religion, accept world views of others, and are socially oriented" (Atwater, 1994), whereas those with a western world view, namely European American males, "emphasize individual competition, believe that people must conquer and dominate nature" and "think that their world views are better" (Atwater, 1994).

Another proponent of this line of thinking demarcates groups based upon field sensitivity (or dependence). Accordingly, the "cultural experiences of Blacks, females, Hispanics, and Native Americans tend to promote a field- sensitive orientation" (Baptiste, 1993), which accounts for their desire that "science concepts be presented in a humanized story format", and their "desire to work with others and to assist others" and a characteristic "high motivation when working individually with teachers" (Atwater, Crockett, Kilpatrick,1996). Conversely, field independent learners (comprised of ethnic groups not included in the field-dependent) are said to typically
prefer "individual recognition, more formal interaction with the teacher, finish first and pursue nonsocial rewards," and prefer that "the details of science concepts be
emphasized" (Atwater, Crockett and Kilpatrick,1996).

If we are to operate on the premise of Science For All, a task early on must be to dismantle such prejudicial groupings at the outset, while recognizing and being sensitive to the great diversity that exists among individual students within as well as across ethnic and cultural boundaries. But the categorization of students, or of any
individual, "by a single microculture membership and the expectation of certain
behaviors in turn are inappropriate and often prove incorrect anyway" (Gollnick, 1992). Kids who fare poorly in science, be they White or Black, male or female, do so "because of systematic inequities in the pedagogical approach to the the teaching of science" (Garibaldi, 1992). Therefore the pedagogical style of science teachers must be reformed to a model of inquiry that suits individual learning styles of all children, regardless of ethnicity or cultural experience.

Equity through Inquiry

The foundations for an ethnically inclusive science education strategy are already at hand. When teachers present science through inquiry, they "plan
for meeting the particular interests, knowledge and skills of each student and build on their questions and ideas" (NRC,1996). Authentic questions that are generated from students' own

experiences are central to inquiry, where "the focus is predominantly on real world phenomena" (NRC,1996). Thus, all children, "regardless of age, gender, cultural or ethnic background, disabilities, interest or motivation in science" can develop the knowledge and skills to be valued contributors to a scientific and technological society (NRC,1996). Equity and systemic reform in science education

have a reciprocal relationship: "Educators cannot successfully attain or accomplish one without the other" (Foundations, 1997). Leaders in the movement for multicultural curricular inclusion in science would do more good for a greater number of American children by urging on the widespread dissemination and utilization of reform programs that outline the inquiry approach, such as the National Science Education Standards. Some of the benefits of inquiry science are:

- Students are actively engaged in doing science, rather than hearing about how it is done
- The real world is brought into the classroom and into students' lives
- Teamwork and collaboration in solving problems and addressing issues are central
- Diverse learning styles are accommodated through various strategies of pursuit–hands-on, research, dialogue, reflection
- Topics lead to connections with other school disciplines
- The thought processes of students are revealed by, and guide the course of, inquiry science (NRC, 1997)

Making a case for inquiry science is to make a case for multicultural science. "Teaching science this way creates classrooms in which all students, not just a select few, can learn science" (Foundations,1997). The only tenable justification for continuing to push for overt multiculturalist techniques would be a failure to universally adopt inquiry science. A traditional classroom—dependent upon textbook and lecture methods of content delivery, emphasizing what we know more than what we do in science, and where a teacher delivers more than receives—will inevitably be riddled with cultural bias. The question would then be whose bias.

As multiculturalists and as science teachers who wish to maintain fidelity to our discipline, we all want students to appreciate the scope and limitations of science, the cultural influences that have and will color it, the societal manifestations of it, and the opportunities inherent within it. But we should not abandon learning theory to "deliver" these notions when student inquiry will better provide for the construction of these meanings for each individual.

Disparity in performance between ethnic populations when it comes to science boils down to attitudes crafted during the science education of the learner (Debaz, 1994). Research on ethnically heterogeneous classrooms supports the value of inquiry science as a means for bolstering the confidence, and subsequently the performance, of students of all ethnic and cultural backgrounds (Yong, 1993; White and Richardson, 1993; Mordi, 1993; Atwater, Wiggins and Gardner, 1995; Catsambis, 1995).

Conclusion

Attitudes among Blacks and immigrants regarding the Army and their prospects in it were surely dim indeed after failing the Alpha 8: Information Test. They were forced to reckon with the notion that perhaps they were ill-suited for military service based upon this measure. Today conscientious people cringe at this gross mismeasure using a tool with no applicable basis for drawing such conclusions. We would demand that at the very least, a form of measure be employed that authentically assesses military service itself before we cast judgment on a soldier's potential. Traditional science pedagogy is a metaphorical Alpha Test. It resembles nothing of the authentic discipline, and convinces worthy members of the population that science is not for them. Rather than take a multicultural tactic against our own version of the Alpha Test by simply amending it to be more inclusive, science education reform advocates, true multiculturalists, want the test thrown out, so that the venture of *doing* science can speak for itself.

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